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DEVELOPMENT OF THE ECONOMIC IMPACT FORECAST SYSTEM (EIFS)--THE --ETC(U)
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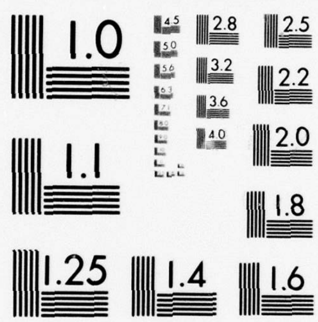
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TECHNICAL REPORT N-35
May 1978
Analytical Model System for Prediction of Environmental Impacts

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DEVELOPMENT OF THE ECONOMIC IMPACT FORECAST SYSTEM (EIFS)—THE MULTIPLIER ASPECTS

LEVEL II

by
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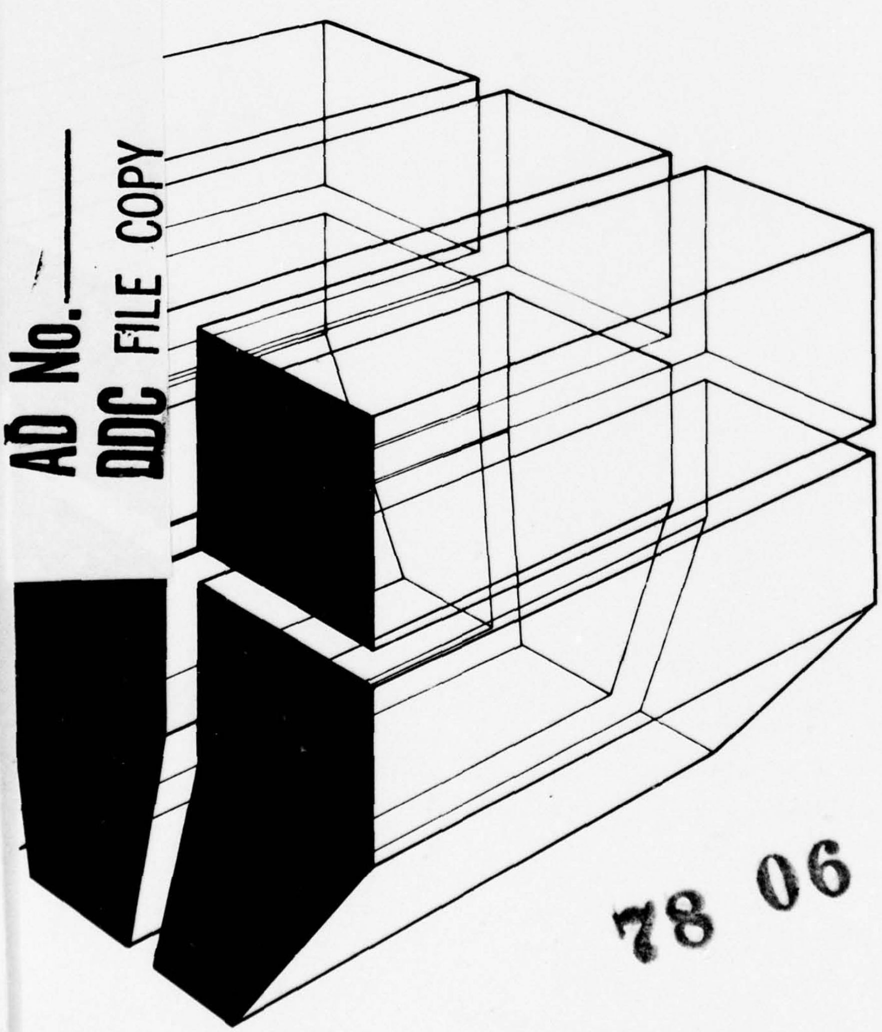

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This report presents refinements to the Economic Impact Forecast System's (EIFS) multiplier calculation that will make it more accurate and user-oriented. Two techniques for meeting National Environmental Policy Act requirements were analyzed, and EIFS was modified according to user needs and cost considerations shown by the analysis. The resultant system compares very favorably with alternative, more expensive, techniques and can provide the Department of the Army with an efficient methodology for regional economic impact assessment.

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FOREWORD

This project was performed for the Directorate of Military Construction, Office of the Chief of Engineers (OCE), under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities," Task 01, "Environmental Quality Management for Military Facilities," Work Unit 006, "Analytical Model System for Prediction of Environmental Impacts." The applicable QCR was 1.03.006.

The work was performed by the Environmental Division (EN), U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL. Dr. Larry Schindler was the OCE Technical Monitor.

This research was made possible through the efforts of DOD personnel, consultants from the University of Illinois, and the scientists and engineers of CERL.

Administrative support and counsel were provided by Dr. R. K. Jain, Chief of EN. COL J. E. Hays is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director.

CONTENTS

TABLES

FIGURES

DEVELOPMENT OF THE ECONOMIC IMPACT FORECAST SYSTEM (EIFS)— THE MULTIPLIER ASPECTS

1 INTRODUCTION

Background

The passage of the National Environmental Policy Act (NEPA) in 1970[1,2] was intended to insure that environmental impacts caused by new Federal projects or actions would be considered. Although the requirement for such impact analysis was originally interpreted as pertaining only to the biophysical environment, court interpretations[3,4] and the scientific problems of separating the biophysical and the socioeconomic aspects have made regional economic analysis an integral part of environmental impact analysis. There is currently no means of efficiently and expeditiously considering socioeconomic impacts for a wide range of project alternatives. The Economic Impact Forecast System (EIFS),[5] a part of the Environmental Technical Information System (ETIS) concept,[6] was initially developed to address this requirement. The principal problem of the preliminary system was the degree of overstatement inherent in the system's estimates of economic impacts. The chosen technique had historically provided a very high estimate relative to results indicated by more expensive alternative techniques.

Objective

The purpose of this study was to improve the EIFS multiplier so that it would more accurately aid the prediction of economic impacts of Army activities and would be cost-effective and efficient to use.

The objective of this report was to document how the multiplier was derived using the Export-Based Location-Quotient technique and to provide specific user requirements while comparing the multiplier with other socioeconomic impact assessment techniques.

Approach

This research first analyzed specific user requirements for EIFS, including responsiveness, geographic coverage, and costs. Existing alternative methodologies for assessing regional economic impact were reviewed and compared to user requirements (Chapter 2).

A disaggregated data base for calculating the export employment multiplier was selected, using the *County Business Patterns*[7,8] detailed employment, and adjustments were made to more accurately reflect regional economic constituency. An algorithm for addressing residual and nondisclosure portions of the employment data was implemented, and a technique was selected that would make estimation of economic impact less conservative and more accurate. A procedure for estimating economic base multipliers through existing input-output tables was examined (Chapter 3).

Mode of Technology Transfer

This report provides the technical backup for the current EIFS multiplier calculation and will provide the necessary documentation for that portion of EIFS modification, update, or maintenance. This report will also provide technical information which can be used as a supplement to DA Pamphlet 200-2.[9]

2 SPECIFIC USER REQUIREMENTS

Responsiveness

The military user often must produce Environmental Impact Assessment (EIA) and Environ-

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[1] National Environmental Policy Act of 1969, 83 Stat 852, *42USC 4321 et seq. (January 1970).*

[2] R. K. Jain, L. V. Urban, and G. S. Stacey, *Environmental Impact Analysis—A New Dimension in Decision Making* (Van Nostrand Reinhold, 1977).

[3] "McDowell vs. Schlessinger," U.S. District Court, Western District of Missouri, Western Division, No. 75-CV-234-W-4 (June 19, 1975).

[4] "Breckinridge et al., vs. Schlessinger," U.S. District Court, Eastern District of Kentucky, No. 75-100 (October 31, 1975).

[5] R. D. Webster, et al., *The Economic Impact Forecast System: Descriptor and User Instructions*, Technical Report N-2/ ADA027139 (U.S. Army Construction Engineering Research Laboratory [CERL], June 1976).

[6] R. D. Webster, et al., *Development of the Environmental Technical Information System*, Interim Report E-52/ADA009668 (CERL, April 1975).

[7] *Environmental/Socioeconomic Data Sources*, Tab A-1 Supplement (Department of the Air Force, and U.S. Department of Commerce, October 1976), pp 136-138.

[8] *County Business Patterns, 1972*, "Employment and Taxable Payrolls, Number and Employment Size of Reporting Units" (U.S. Department of Commerce, Bureau of the Census, 1973).

[9] *The Economic Impact Forecast System—Descriptor and User Instructions*, Department of the Army (DA) Pamphlet No. 200-2 (DA, December 1976).

mental Impact Statement (EIS) documents in extremely short time periods. This means that many types of analyses must be accomplished rapidly. Although scientific validity cannot be discarded in the interest of rapid analyses, the time spent gathering and analyzing readily available data is often the limiting factor. This is particularly important in the early decision-making stages where entire alternatives can be neglected because of inadequate management data. Since economic surveys require large amounts of time, there is a need for a system which can provide sufficient data and analysis tools for evaluating preliminary alternatives early, without expensive, time-consuming effort.

Geographic Coverage

The Army, including reserve components, has facilities in most states, so any analysis methodology must be capable of accommodating many diverse regions. The data base must cover the entire United States uniformly and consistently, to insure the comparativeness of the model results. The system must have flexible regional definition at a level of disaggregation suitable for EIA/EIS analyses.

Cost Considerations

The user of any technique for meeting NEPA requirements must be concerned with the cost of the technique, not only in terms of absolute cost, but in terms of cost versus amount of useful information derived. The cost of estimating economic impact can vary substantially. Two techniques that are currently available are used for EIA/EIS preparations—the Input-Output (I-O) technique and the Export-Base Location-Quotient technique (EB/LQ). Appendix A provides a detailed discussion of each technique. The following paragraphs provide a simplified discussion.

I-O Technique

I-O models yield detailed information by sector. Currently, I-O models are developed in one of two ways: (1) data are developed for an economic region based on survey or other locally developed information (for even a small region, this methodology is very expensive and time consuming), and (2) a national I-O table is reduced to regional proportions. This technique requires regional or local consultation input to insure that the table reflects the local industrial composition.

The I-O technique, in general, is expensive in both time and money. Most of the work and costs are for the steps that produce a regionally specific I-O table. Figure 1 is an example of an I-O table.

Using this methodology insures a great deal of numerical processing and, hence, provides a unique estimate of disaggregate impacts. For example, by using a good I-O methodology, the impact of a particular Department of the Army (DA) project on some specialized segment of the regional employment profile can be determined. Since other techniques cannot offer this level of detail, the I-O is useful for analyzing effects on, for example, employment distribution. I-O models therefore provide detailed data as part of their output but require high levels of funding.

EB/LQ Technique

Export-base models do not offer the same level of detail as an I-O model. The location-quotient type of export-base model can be developed from secondary data sources, which reduces the need for field data collection. This reliance on secondary data means that an EB/LQ model can be used for all or any combination of units for which data are available. Since the county unit is the smallest geographic unit for which good secondary data sources exist, the lowest practical level of disaggregation for this type of model is the county level.

This technique has developed a reputation for overestimating the impact. In the documentation of impacts for environmental studies, however, this overstatement can sometimes be advantageous, since it is a conservative or "worst case" estimate. The problem currently stems from the degree of overstatement. Although no traditional laboratory experiment with control variables can be performed to establish the true multiplier, some modification to the multiplier calculation and analysis of results can offset the effects of this trend. Research efforts currently under way at CERL to improve the calculation technique and guidelines for interpreting the multiplier results will be presented later in this report. When set up, the EB/LQ models are easy to use and require little time and money to operate.

Different Multipliers (Employment as a Proxy)

There has been some controversy about which multiplier or group of multipliers should be used.

Sector number	Sector name	Single sector aggregate	25	26	27	28	29
			Expenditure pattern (technical coefficients) by resort income class				
			$0- $2,000	$2,000- $6,000	$6,000- $10,000	$10,000- $20,000	$20,0 $30,0
1	Timber production	0.000	0.000	0.000	0.000	0.000	0.00
2	Timber operators	0.000	0.000	0.000	0.000	0.000	0.00
3	Sawmills	0.000	0.000	0.000	0.000	0.000	0.00
4	Agriculture	0.000	0.000	0.000	0.000	0.000	0.00
5	Food processing	0.000	0.000	0.000	0.000	0.000	0.00
6	Stone, clay, glass, and cement	0.000	0.000	0.000	0.000	0.000	0.0
7	Other industry n.e.c.*	0.017	0.028	0.016	0.009	0.020	0.01
8	Construction and contracting	0.059	0.051	0.131	0.042	0.073	0.04
9	Transportation and warehousing	0.000	0.000	0.000	0.000	0.000	0.00
10	Lumber, building materials, and hardware	0.059	0.088	0.082	0.059	0.079	0.05
11	Automobile and truck sales, machinery, and equipment supplies	0.022	0.019	0.000	0.059	0.047	0.00
12	Gasoline and service stations	0.028	0.060	0.041	0.021	0.026	0.0
13	Automotive and machinery repair, supplies, and salvage	0.007	0.014	0.008	0.006	0.006	0.0
14	Grocery, drug, and sundry sales	0.060	0.019	0.045	0.071	0.052	0.18
15	Dry goods, appliances, furniture, and other household goods n.e.c.*	0.045	0.037	0.029	0.038	0.067	0.1
16	Food and beverage service	0.000	0.000	0.000	0.000	0.000	0.00
17	Other retail n.e.c.*	0.007	0.005	0.004	0.006	0.006	0.0
18	Professional services	0.006	0.009	0.000	0.003	0.012	0.0
19	Skilled and semiskilled trades and services	0.019	0.009	0.033	0.015	0.029	0.01
20	Finance, real estate, and insurance	0.100	0.181	0.061	0.068	0.137	0.0
21	Hotel, motel, and commercial rental	0.000	0.000	0.000	0.000	0.000	0.0
22	Electric utilities	0.039	0.107	0.049	0.027	0.044	0.01
23	Communications	0.030	0.042	0.024	0.027	0.038	0.01
24	Wholesale and distributing	0.115	0.102	0.094	0.089	0.169	0.21
25	Resorts: $0-$2,000 gross income	0.000	0.000	0.000	0.000	0.000	0.00
26	Resorts: $2,000-$6,000 gross income	0.000	0.000	0.000	0.000	0.000	0.00
27	Resorts: $6,000-$10,000 gross income	0.000	0.000	0.000	0.000	0.000	0.00
28	Resorts: $10,000-$20,000 gross income	0.000	0.000	0.000	0.000	0.000	0.00
29	Resorts: $20,000-$30,000 gross income	0.000	0.000	0.000	0.000	0.000	0.00
30	Resorts: $30,000-$500,000 gross income	0.000	0.000	0.000	0.000	0.000	0.0
31	Recreation and entertainment	0.018	0.019	0.008	0.038	0.020	0.03
32	Education	0.000	0.000	0.000	0.000	0.000	0.00
33	Nonprofit organizations	0.007	0.009	0.004	0.009	0.014	.....
34	Public schools	0.000	0.000	0.000	0.000	0.000	0.00
35	Local government	0.000	0.000	0.000	0.003	0.000	0.00
36	County government	0.059	0.140	0.086	0.074	0.055	0.01
37	State government (local unit)	0.000	0.000	0.000	0.003	0.000	0.00
38	Federal government (local unit)	0.000	0.000	0.000	0.000	0.000	0.00
39	Households	0.098	0.000	0.209	0.226	0.014	0.00
40	Overflow	0.000	0.000	0.000	0.000	0.000	0.00
	Total internal	0.795	0.953	0.924	0.893	0.908	0.87
41	Households, external	0.023	0.005	0.000	0.000	0.000	0.00
42	State government, external	0.046	0.000	0.016	0.027	0.000	0.01
43	Federal government, external	0.041	0.023	0.029	0.044	0.058	0.01
44	All other external	0.092	0.019	0.029	0.036	0.023	0.09
	Total external	0.202	0.047	0.074	0.107	0.081	0.12
	Total	0.997	1.000	0.998	1.000	0.989	0.99

*n.e.c. means not elsewhere classified.

Figure 1. I-O example. (From J. M. Hughes, *Forestry in Itasca County's Economy,* Misc. Report 95 [University of Minnesota], 1970).

28	29	30		25	26	27	28	29	30	
resort income class				Direct-plus-indirect effect (direct-plus-indirect coefficients) by resort income class						
$10,000-$20,000	**$20,000-$30,000**	**$30,000-$500,000**	***Single sector* aggregate**	***$0-* $2,000**	**$2,000-$6,000**	**$6,000-$10,000**	**$10,000-$20,000**	**$20,000-$30,000**	**$30,000-$500,000**	
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1
0.000	0.000	0.000	0.003	0.001	0.005	0.003	0.004	0.003	0.002	2
0.000	0.000	0.000	0.009	0.012	0.015	0.009	0.011	0.008	0.005	3
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4
0.000	0.000	0.000	0.007	0.007	0.009	0.009	0.007	0.009	0.007	5
0.000	0.000	0.000	0.007	0.008	0.013	0.007	0.009	0.006	0.005	6
0.020	0.018	0.012	0.032	0.048	0.037	0.027	0.037	0.030	0.005	7
0.073	0.048	0.025	0.094	0.100	0.176	0.081	0.115	0.073	0.052	8
0.000	0.000	0.000	0.012	0.014	0.013	0.012	0.014	0.014	0.003	9
0.079	0.054	0.018	0.081	0.114	0.114	0.083	0.104	0.071	0.035	10
0.047	0.000	....	0.073	0.078	0.069	0.121	0.099	0.035	0.048	11
0.026	0.030	0.012	0.051	0.087	0.072	0.048	0.050	0.047	0.033	12
0.006	0.006	0.003	0.021	0.034	0.028	0.022	0.021	0.017	0.015	13
0.052	0.188	0.033	0.158	0.128	0.180	0.197	0.147	0.250	0.139	14
0.067	0.133	0.012	0.077	0.074	0.074	0.080	0.100	0.155	0.016	15
0.000	0.000	0.000	0.014	0.016	0.020	0.019	0.014	0.009	0.016	16
0.006	0.030	0.003	0.012	0.010	0.010	0.011	0.011	0.034	0.007	17
0.012	0.006	0.005	0.023	0.030	0.023	0.024	0.029	0.018	0.022	18
0.029	0.012	0.007	0.028	0.034	0.044	0.025	0.039	0.018	0.014	19
0.137	0.061	0.073	0.164	0.259	0.146	0.144	0.207	0.111	0.128	20
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	21
0.044	0.012	0.015	0.054	0.125	0.069	0.044	0.059	0.023	0.029	22
0.038	0.012	0.023	0.046	0.062	0.045	0.046	0.056	0.026	0.037	23
0.169	0.218	0.062	0.173	0.184	0.175	0.152	0.228	0.264	0.106	24
0.000	0.000	0.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	25
0.000	0.000	0.000	1.000	0.000	1.000	0.000	0.000	0.000	0.000	26
0.000	0.000	0.000	1.000	0.000	0.000	1.000	0.000	0.000	0.000	27
0.000	0.000	0.000	1.000	0.000	0.000	0.000	1.000	0.000	0.000	28
0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	1.000	0.000	29
0.000	0.000	0.000	1.000	0.001	0.001	0.001	0.001	0.000	1.000	30
0.020	0.030	0.003	0.025	0.026	0.017	0.047	0.026	0.034	0.010	31
0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.000	0.001	32
0.014	....	0.002	0.014	0.019	0.013	0.017	0.023	0.006	0.005	33
0.000	0.000	0.000	0.043	0.083	0.060	0.052	0.042	0.020	0.000	34
0.000	0.000	0.000	0.025	0.043	0.034	0.031	0.025	0.013	0.017	35
0.055	0.018	0.013	0.091	0.179	0.128	0.112	0.090	0.043	0.042	36
0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	37
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	38
0.014	0.000	0.267	0.449	0.495	0.632	0.587	0.429	0.285	0.500	39
0.000	0.000	0.000	0.020	0.027	0.030	0.027	0.020	0.013	0.021	40
0.908	0.876	0.588	2.807	3.302	3.253	3.042	3.018	2.635	2.398	
0.000	0.000	0.067								41
0.000	0.012	0.108								42
0.058	0.012	0.040								43
0.023	0.097	0.197								44
0.081	0.121	0.412								
0.989	0.997	1.000								

The three most often cited are earnings multipliers, income multipliers, and employment multipliers. The EIFS model uses the employment multiplier as a surrogate for other multipliers.

The primary difference among the multipliers is the data from which they are derived. The technique for deriving each is essentially the same, with the product being some static measure of the total change (both direct and indirect) attributable to some exogenous change in the economy. The concept of a multiplier remains the same, whether this measure is in the form of employment or income.

Data to calculate the earning and income multipliers are often difficult to obtain in a usable form, especially for small geographic areas. Employment data are generally more available, either from published or unpublished sources. Additionally, employment data have the advantage of not being affected by inflationary trends; this makes the inflationary adjustment to establish some "present worth" type of derivation needless.

To investigate the inherent differences between these multipliers, a quick comparison can be made from the results of an unpublished report done for environmental studies by the Bureau of Economic Analysis (BEA).[10]

Table 1 shows that the differences average approximately 15 percent for the 15 areas sampled. It should also be noted that the difference between the two multipliers is less than 20 percent of the value of the employment multiplier in 14 of the 15 cited cases.

Although more work must be done to verify this assumption, it appears that the employment multiplier is an adequate surrogate for the income multiplier, which is difficult to calculate because of data problems.

Table 1

A Comparison of Selected BEA Results

Installation	Employment	Income	% Difference
Fort Devens, MA	2.86	2.56	10.49
Fort Indiantown Gap, PA	2.70	2.33	13.70
Fort MacArthur, CA	2.94	2.56	12.92
Schilling Manor, KS	3.13	2.22	29.07
Fort Drum, NY	2.56	2.08	18.75
Oakdale Support Detachment, PA	2.94	2.50	14.96
Fort Meade, MD	3.33	2.70	18.91
Fort Gordon, GA	2.22	2.00	9.90
Fort Lewis, WA	2.50	2.27	9.20
Fort Polk, LA	2.44	2.04	16.39
Fort Huachuca, AZ	2.94	2.38	19.04
Fort Ord, CA	2.22	1.92	13.51
Fort Campbell, KY	1.67	1.49	10.77
Vint Hill Farms, VA	2.94	2.44	17.00
Aberdeen PG, MD	2.56	2.78	8.59

3 THE EIFS MULTIPLIER

Evolution

The Change From Two-Digit to Four-Digit Detail

The present EIFS system has evolved from the two-digit multiplier used 1 year ago to an improved four-digit multiplier. The original EIFS multipliers were based on the Bureau of Census classification of industries. Since the more aggregated approach would lead to an extreme overstatement of the multiplier, the next step in the EIFS development was to disaggregate the employment data. This was done by using the BEA County Business Patterns (CBP) computer tapes, which break employment down into the four-digit Standard Industrial Category (SIC) code.[11] The previous calculations had been done at an approximate two-digit level. This four-digit multiplier should more accurately reflect the actual situation, since the additional detail would be more apt to catch small interindustry transactions. This four-digit multiplier is still an overstatement of the multiplier, although the actual or exact multiplier cannot ever be scientifically validated. Table 2 shows the effects of disaggregation. Appendix B provides an example of the four-digit employment profile for two regions and the resultant multiplier.

Assignment of Exogenous Sectors

The next step was to adjust the calculation to more accurately reflect the region's economic constituency. The first step was to consider all Federal employment as exogenous to the region since funds to pay Federal employees are derived from *all* regions and are then respent in specific locations. This, in effect, means that money is flowing into the

[10] *Economic Multipliers for Army Base Realignment Studies*, DCA-R-33 (Directorate of Cost Analysis, Office of the Comptroller of the Army, July 1976).

[11] *Standard Industrial Classification Manual, 1967* (Executive Office of the President, Bureau of the Budget, 1967).

Table 2

The Effects of Disaggregation*

Area	Multiplier Division Level Data	Two-Digit Level Data	Three-Digit Level Data	Four-Digit Level Data
Georgia	19.01165	6.57299	5.49690	4.84118
Kansas	10.30828	6.51033	4.78054	4.29892
West Virginia	8.32867	4.17737	3.48111	3.14186
Philadelphia Standard Metropolitan Statistical Area (SMSA)	17.24355	9.10950	6.03754	5.18102
Washington, DC SMSA	3.30660	2.97354	2.81134	2.79792
Fort Monmouth Tri-County, NJ	15.68284	7.17098	5.18690	4.47776
Monmouth County, NJ	7.22016	5.16081	3.88481	3.49575

*From Andrew M. Isserman, "The Location Quotient Approach to Estimating Regional Economic Impacts," *AIP Journal* (January 1977).

Employment data sources: *County Business Patterns, 1972* augmented by data on governmental employment obtained from the Bureau of Economic Analysis, U.S. Department of Commerce.

region from outside, and that those receiving this compensation should be assigned to the export category. In addition, all hotel, tourist court, and motel employment was also treated as exogenous. This adjustment, made to identify another essentially exogenous sector, will not be applicable when regions become larger. For example, at a local level, most hotel and tourist sector customers will be nonlocal. As the region becomes larger (for example, the state level), the proportion of the employment which can be considered truly exogenous becomes smaller. Since EIFS usage normally remains at a very localized level, the entire sector is treated as exogenous, or exporting.

Table 3 indicates the results of these modifications to the EIFS multiplier technique.

The Disclosure Algorithm

In preparing CBP tapes, many entries were not disclosed to prevent violating the privacy or integrity of particular industries or firms, which created a problem in using these data for a detailed study. In the aggregate (for example, the multiplier calculation), the impact of these nondisclosures was found to be marginal, but sufficient to warrant developing a disclosure algorithm for the EIFS system. Along with the basic employment by industrial category, many insights could be gained regarding the nondisclosed industries. From the data, it is possible to read the number of nondisclosed firms in a region directly and the size category into which they fall. Figure 2 is an example of CBP tape format. The chosen disclosure algorithm employs a holistic approach to the data, using an entire county as its basic

Table 3

The Effect of Exogenous Assignment on the EIFS Multipliers (Employment Multipliers Calculated at the Four-Digit Level With and Without Adjustment for Federal Employment and Hotels, Tourist Courts, and Motels)

Area	Unadjusted Four-Digit	A* Adjusted Four-Digit	B** Adjusted Four-Digit
Georgia	4.84118	3.73989	—
Kansas	4.29892	3.42003	—
West Virginia	3.14186	2.88231	—
Philadelphia SMSA	5.18102	3.94985	3.86911
Washington SMSA	2.89892	2.38438	2.33352
Fort Monmouth Tri-County NJ	4.47776	3.504946	3.42423
Monmouth County NJ	3.49575	2.87694	2.79661

*Federal Government Employment as Exogenous.

**Federal Government and Hotel/Tourist Employment as Exogenous.

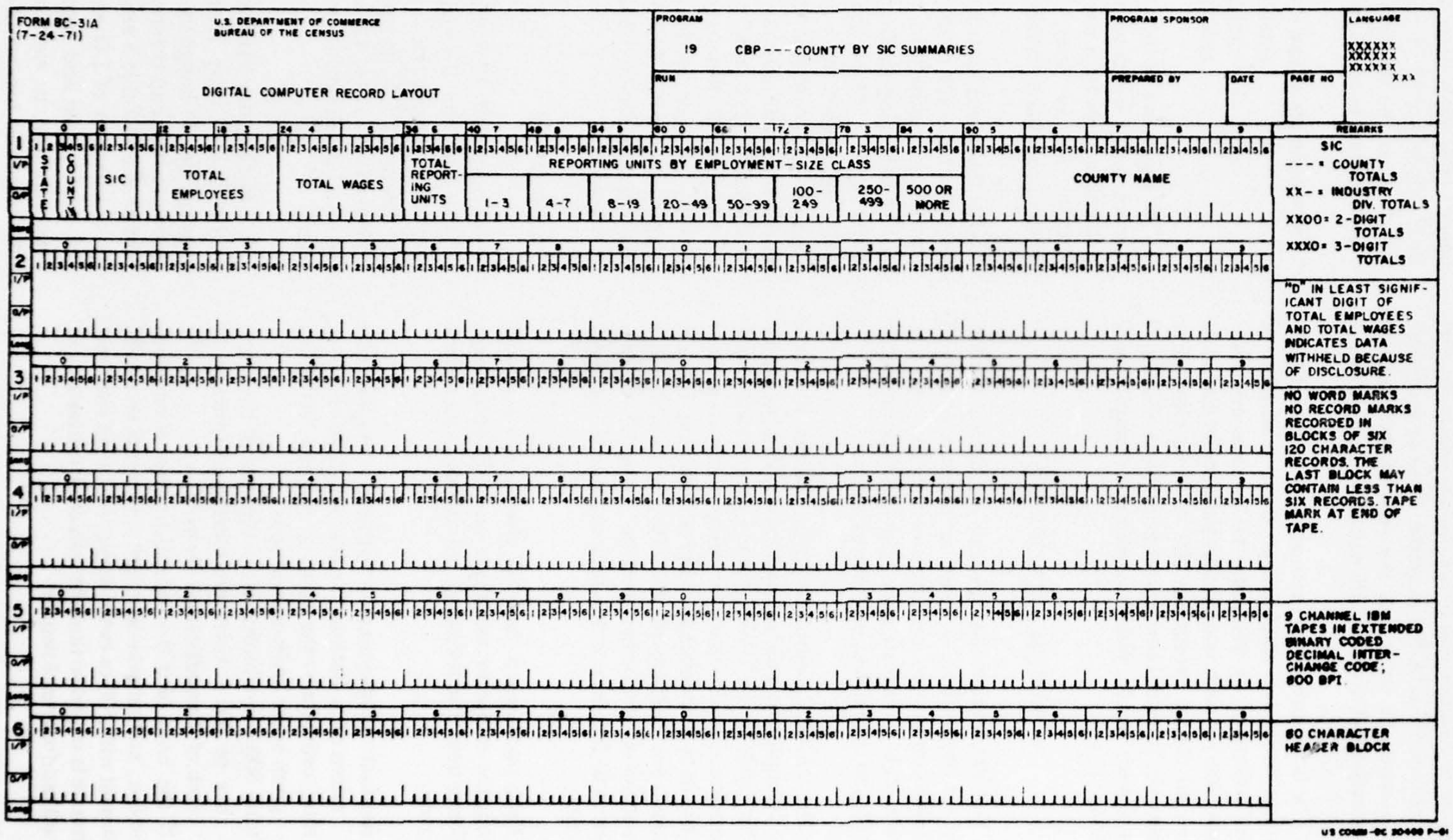

Figure 2. CBP tape format.

unit, rather than a single industry. It operates from the top down, estimating undisclosed divisions before estimating two-digit classifications, two-digit before three-digit, etc. Estimates are consistent with the rest of the data. For example, if one or more divisions must be estimated, the sum of the disclosed and estimated divisions will equal total employment.

The basic estimation method—the midpoint technique—estimates employment from a number of establishments by assuming an average establishment size for each bounded establishment size class (i.e., all classes except the 500 or more class). For example, 10 establishments of a size class of 20 to 49 employees would yield an estimated employment of 345:

$$10 * ([20 + 49]/2) = 345$$

The 500 or more class presents a problem that has not yet been solved. It spans an enormous range of establishment sizes, making any midpoint-type estimate highly unsatisfactory. The solution presented here is an acceptable, effective expedient.

The central algorithm accepts a "father" industry, for example, manufacturing (disclosed or previously estimated), and all immediately descendent "son" industries (smaller manufacturing concerns) present in the data, both disclosed and undisclosed. If some "sons" are undisclosed, the effect is to allocate to them the difference between the "father's" employment and the sum of the disclosed "sons'" employment.

Each undisclosed "son" is given a raw estimate, using the midpoint technique on its establishment information. The following quantities are then computed:

residual employment—"father's" employment minus each disclosed "son's" employment
total estimated—the sum of the raw estimates given to the undisclosed "sons"
total 500+ establishments—the sum of the number of 500+ class establishments present in each of the undisclosed "sons."

If the total of 500+ establishments is equal to zero (i.e., no undisclosed "son" represents an establishment with 500 or more employees), then each raw estimate is scaled so that the sum of all estimates will equal residual employment:

Raw estimate = (raw estimate/total) (residual).

If the total of 500+ establishments is greater than zero, the total estimated is subtracted from residual (residual now represents "total undisclosed employment in the 500+ class alone"), and this new residual is apportioned to each undisclosed "son," depending on the number of 500+ class establishments present in the "son":

Raw estimate = raw estimate + (500+ establishments in this industry/ total 500 = establishments*) residual.

The algorithm is then recursively applied in turn to each "son," which serves as the new "father." The procedure stops for a particular "bloodline" when a "father" has no "sons," e.g., when a four-digit industry is used as a "father."

One theoretical drawback in this estimation technique is that some of the residual employment allocated to the undisclosed "sons" is truly residual, that is, not belonging to the undisclosed "sons," but to some "son(s)" which are missing entirely from the data base. This is not a great problem, since limited experiments show that the difference in the multipliers with and without residual classifications at this level is very small. To conduct these experiments, the algorithm was modified to preserve the identity of true residuals, and to estimate their magnitudes. If it is desirable to adopt this approach in the future, the modified algorithm could be made available.

Current Status

The current EIFS multiplier calculation is a result of the evolution defined in the preceding paragraphs. Its calculation is interactively available for any county unit or grouping of county units in the United States. Table 4 is an example of the effects of the latest development on the resultant EIFS multipliers.

Comparing the EIFS multiplier to those multipliers generated by alternative techniques seems appropriate. Although each technique has certain characteristics and theoretical shortcomings, the results shown in Table 5 are encouraging. Admittedly, the comparison of I-O and export-base multipliers and employment and income multipliers should be done carefully. In each case, specific assumptions and designated use would need analysis to provide a fair comparison. However, the relative strengths of

Table 4

Comparison of Recent EIFS Modifications to Previous Results

Region (counties)	Previous EIFS	Current EIFS	Hand-Calculated EIFS
Monmouth, NJ	3.6020	2.7663	2.7966
Monmouth/Ocean/ Middlesex, NJ	4.4961	3.2756	3.4242
Philadelphia, SMSA	5.5362	3.6930	3.8691
Washington, SMSA	2.5397	2.2699	2.3335
Champaign, IL	2.4409	2.0887	
St. Clair, IL	2.9297	2.5671	
Madison, IL	2.7537	2.4147	
Los Angeles, CA	5.4645	3.9295	
Marin, CA	3.3122	2.4217	
Cook, IL	4.4247	3.3253	
Fort Bragg	2.2613	2.0062	
Memphis Defense Depot	4.0039	3.0805	

the EIFS multiplier technique are indicated. The cost of the EIFS multiplier is significantly less than that of the indicated alternatives. In addition, the EIFS multiplier is better suited to user requirements through the cost-effective provision of flexible regional definition on a broad scope, and a scientifically based multiplier technique specific to the defined region.

The Lower Bound—A Bracketing Approach

Given the generally accepted tendency of the EB/LQ approach to overestimate the actual multiplier phenomenon, selecting a technique that is known to underestimate would essentially bracket the actual multiplier. If the identified range were small enough, the relative impacts on alternative economic regions would be possible and the controversy over which multiplier to use might diminish.

The approach recommended by Mathur and Rosen estimates exports in three steps.[12,13] Employment in the i^{th} industry in the region (E_{ir}) is regressed against national employment (E_n) in one of the two following forms:

$$E_{ir} = a + bE_n \qquad \text{[Eq 1]}$$

$$\log E_{ir} = a + bE_n \qquad \text{[Eq 2]}$$

[12]Andrew M. Isserman, *A Bracketing Approach for Estimating Regional Economic Impact Multipliers and a Procedure for Assessing Their Accuracy*, paper presented at the Workshop on the Methodology of Economic Impact Analysis (13-15 April 1977).

[13]V. Mathur and H. Rosen, "Regional Employment Multiplier: A New Approach," *Land Economics*, Vol 50 (February 1974).

Table 5

Comparison of Recent EIFS Modifications to Other Multiplier Techniques

Region		Other Techniques	Current EIFS System
1.*	Howard Co., TX	1.755	2.071
	Val Verde Co., TX	1.798	1.692
	Lubbock Co., TX	2.153	2.9402
	Garfield Co., OK	2.010	2.5406
	Lowndes Co., MS	1.956	1.9567
	Dallas Co., AL	2.031	2.0478
2.**	Georgia #	1.75 - 3.11	2.8384
	Kansas # #	1.11 - 3.69	2.7636
	Philadelphia SMSA §	4.72	2.6936
3.‖	Fort Devens, MA	2.86	3.4222
	Fort Indiantown Gap, PA	2.70	3.1373
	Fort MacArthur, CA	2.94	3.9759
	Schilling Manor, KS	3.13	2.7854
	Fort Drum, NY	2.56	2.2404
	Oakdale Support Depot, PA	2.94	2.9195
	Fort Meade, MD	3.33	2.5245
	Fort Gordon, GA	2.22	2.3229
	Fort Lewis, WA	2.50	2.4393
	Fort Polk, LA	2.44	2.3651
	Fort Huachuca, AZ	2.94	2.5766
	Fort Ord, CA	2.22	2.0016
	Fort Campbell, KY	1.67	1.8548
	Vint Hill Farms, VA	2.94	2.3122
	Aberdeen PG, MD	2.56	2.4274

*Derived for the U.S. Air Force by contractor-generated I-O; documented in Personal Communication; CPT Dick Padgett, Air Force Civil Engineering Center, Tyndall AFB, Panama City, FL.

**Other established I-O tables.

W. Schaffer, E. Laurant, and E. Sutter, *Using the Georgia Economic Model* (Georgia Institute of Technology, 1972).

M. Emerson, *The Interindustry Structure of the Kansas Economy* (Kansas Department of Economic Development, 1969).

§W. Isard and T. Langford, *Regional Input-Output Study: Recollections, Reflections, and Diverse Notes on the Philadelphia Experience* (Massachusetts Institute of Technology Press, 1971).

‖*Economic Multipliers for Army Base Realignment Studies*, DCA-R-33 (Directorate of Cost Analysis, Office of the Comptroller of the Army, July 1976).

where a and b are constants. After the parameters have been estimated, the mean values of E_{ir} and E_n are substituted into the regression equations, and both sides of each equation are divided by the term on the left side. The results are:

$$1 = \frac{a}{\overline{E}_{ir}} + \frac{b\overline{E}_n}{\overline{E}_{ir}} \qquad \text{[Eq 3]}$$

or

$$1 = \frac{a}{\log \overline{E}_{ir}} + \frac{b\overline{E}_n}{\log \overline{E}_{ir}} \qquad \text{[Eq 4]}$$

Mathur and Rosen argue that the first term on the right side of each equation is the local share, "employment which is insensitive to changes in outside employment," and that the second term is the export share, "which is sensitive to total employment in the rest of the world." When the export share is estimated, it can be multiplied by E_{ir} to estimate exports, X_{ir}.

Mathur and Rosen offer this procedure as a "new approach for conducting economic base analysis" in light of "the major weakness of base theory," which for them is "the lack of an acceptable and objective technique to identify the export (nonlocalized) and service (localized) employment in the local economy." However, their technique ignores the basic assumption of economic base theory, namely that local employment is a function of export employment (a relationship which they themselves assume to be linear). By assigning all employment which is sensitive to national employment to exports, they also assign to exports the portion of local employment which is sensitive to export employment and thereby sensitive to national employment. Moreover, since the method assigns employment in industries which are growing both nationally and regionally to exports, it will tend to assign service industries and local government to exports because of recent secular trends. Thus, the equations overestimate exports and underestimate the multiplier. This argument is presented in more detail in a publication by Isserman,[14] which includes a discussion of alternatives to the total national employment variable in the regression equations.

Although the technique is one which often underestimates, it is valuable to EIFS. With the controversy arising over the actual value of the multipliers, this technique can provide a lower bound. If this technique is coupled with the EB/LQ-derived upper bound, a bracketing of the effect may be possible. CERL is currently conducting research in this area.

A Comparison to Survey-Based Data

One advantage to the EB/LQ technique is its dependence on nonsurvey (indirect) information. The actual difference in end results can be estimated by comparing an EB/LQ technique with actual survey data against which the export-base theory has been applied.

To estimate an economic base multiplier correctly with survey data, it is necessary to gather information on interindustry transactions, as well as on exports and local sales. Without the interindustry information, the analyst cannot estimate indirect exports, e.g., the windows sold to a local automobile firm but exported as a part of the automobiles. Such interindustry data form the essence of I-O tables. In fact, it would be a waste of good interindustry data to use them simply to estimate an economic base multiplier rather than sectoral multipliers. However, the interindustry flow data, available in existing I-O tables, represent an unused source of benchmark data for evaluating nonsurvey-based economic base multipliers.

This section provides a procedure for estimating economic base multipliers by aggregating I-O tables. Conventionally, interindustry transaction flows are manipulated to generate a matrix of regional coefficients whose entries are elements of the form

$$r_{ij} = (X_{ij}/X_j) \qquad \text{[Eq 5]}$$

where X_{ij} represents flows industry-to-industry and X_j represents j's output (usually measured in dollars).

The procedure used here instead calculates "sales" coefficients of the form

$$p_{ij} = (X_{ij}/X_i) \qquad \text{[Eq 6]}$$

where X_i represents i's output.

Whereas r_{ij} represents a flow from i to j per dollar of j's output, P_{ij} represents that flow per dollar of i's output. Thus, P_{ij} represents the share of industry i's total output which is sent to industry j. The same calculation is made for flows to the final demand sectors—$f_{ik} = (X_{ik}/X_i)$, where ik represents the k^{th} final demand sector.

The next step consists of multiplying the p_{ij}, or P matrix, and the f_{ij}, or F matrix, thereby allocating a portion of the interindustry sales to the final demand sectors. Illustrating with a 3×3 interindustry matrix and a 2×3 final demand matrix, let

$$P = \begin{bmatrix} .05 & .15 & .10 \\ .05 & .10 & .05 \\ .10 & .10 & .10 \end{bmatrix} \text{ and } F = \begin{bmatrix} .20 & .40 \\ .70 & .10 \\ .20 & .50 \end{bmatrix}$$

[14] Andrew M. Isserman, "Regional Employment Multiplier: A New Approach: Comment," *Land Economics* (August 1975).

then

$$F_I = PF = \begin{bmatrix} .135 & .09 \\ .09 & .06 \\ .11 & .11 \end{bmatrix}$$

The first rows of the P and F matrices indicate that Industry One's sales are distributed 5 percent to Industry One, 15 percent to Industry Two, 10 percent to Industry Three, 20 percent to final demand sector one, and 50 percent to final demand sector two. According to the F_I matrix, of the 30 percent sold to other industries, 13.5 percentage points are traced to the first final demand sector, and nine percentage points to the second.

The logic of that allocation is simple: 20, 70, and 20 percent of the three industries' output goes directly to the first final demand sector, and 5, 15, and 10 percent of Industry One's output goes directly to the three industries; thus, 20 percent of the 5 percent, 70 percent of the 15 percent, and 20 percent of the 10 percent indirectly goes to that final demand sector. Therefore, $(.20)(.05) = (.70)(.15) = (.20)(.10)$, or .135 of Industry One's output, is indirectly traced for the first final demand sector. The only assumption underlying this estimating procedure is that the intermediate goods shown in the P matrix are distributed in the same ratio as the final products. A similar procedure for estimating indirect sales to final demand is found in the publications referenced below.[15,16]

So far, 92.5, 95, and 92 percent of the output of the three industries has been allocated to the final demand sectors. Assuming that the unallocated intermediate sales are distributed in the same proportions as the initial intermediate sales, the next round of intermediate sales can be allocated in final demand by premultiplying PF by a diagonal matrix whose elements are the remaining shares of the industries' output (.075, .05, and .08) divided by the initial share of the industries' output going to the other industries (.30, .20, and .30). However, the indirect sales to final demand which would be generated by this procedure are proportional across rows to the elements in PF. Rather than iterating in this fashion, the entire intermediate output can be allocated in one step after determining F.

A new matrix L is defined whose elements are the elements of F_I divided by the respective row sum from F_I, or

$$\begin{bmatrix} .135/.225 & .09/.225 \\ .09/.15 & .06/.15 \\ .11/.22 & .11/.22 \end{bmatrix} = \begin{bmatrix} .6 & .4 \\ .6 & .4 \\ .5 & .5 \end{bmatrix}$$

The matrix L is then premultiplied by a diagonal matrix whose elements are equal to 1 minus the row sums of the respective rows in the original F matrix. Thus, total indirect sales to the final demand sectors are estimated as shares of output as follows:

$$F_{I\Sigma} = \begin{bmatrix} .3 & 0 & 0 \\ 0 & .2 & 0 \\ 0 & 0 & .3 \end{bmatrix} \begin{bmatrix} .6 & .4 \\ .6 & .4 \\ .5 & .5 \end{bmatrix} \begin{bmatrix} .18 & .12 \\ .12 & .08 \\ .15 & .15 \end{bmatrix}$$

and to total direct and indirect sales as follows:

$$F_\Sigma = F + F_{I\Sigma} = \begin{bmatrix} .20 & .50 \\ .70 & .10 \\ .20 & .50 \end{bmatrix} + \begin{bmatrix} .18 & .12 \\ .12 & .08 \\ .15 & .15 \end{bmatrix} = \begin{bmatrix} .38 & .62 \\ .82 & .18 \\ .35 & .65 \end{bmatrix}$$

The matrix F_Σ shows that 38 percent of the first industry's output was traced to the first final demand sector, and 62 percent was traced to the second.

These percentage shares can be expressed in units of sales, earnings, or employment by premultiplying F by a diagonal matrix Q whose nonzero elements are the region's sales, earnings, or employment in the row industries. For example:

$$QF_\Sigma = \begin{bmatrix} 20,000 & 0 & 0 \\ 0 & 120,000 & 0 \\ 0 & 0 & 100,000 \end{bmatrix} \begin{bmatrix} .38 & .62 \\ .82 & .18 \\ .35 & .65 \end{bmatrix} = \begin{bmatrix} 7,600 & 12,400 \\ 98,400 & 21,600 \\ 35,000 & 65,000 \end{bmatrix}$$

The data found in QF_Σ enable the calculation of a survey-based economic base multiplier when it is known which of the final demand sectors are exogenous. Assuming that the first final demand sector is exogenous and the second is not, the multiplier is calculated by dividing the sum of the elements of the first column of QF, namely the exogenous activity, into the sum of the diagonal elements of Q, or total activity. For the example calculated here, the total impact multiplier is 240,000/141,000, or 1.70.

The decision of which final demand sectors to treat as exogenous enables the differentiation between short- and long-run multipliers. For instance, Tiebout[17] assumed that of the seven final demand

[15] C. Tiebout, *The Community Economic Base* (Committee for Economic Development, 1962).

[16] W. Hansen and C. Tiebout, "An Intersectoral Flow Analysis of the California Economy," *Review of Economics and Statistics*, Vol 45 (1963), pp 409-418.

[17] C. Tiebout, *The Community Economic Base* (Committee for Economic Development, 1962).

sectors—private exports, exports to the Federal government, local consumption, local business investment, local housing investment, local government investment, and local government current expenditure—all but consumption are exogenous in the short run, and only private exports and exports to the Federal government are exogenous in the long run.

Thus, the procedure described here can be used to generate survey-based economic base multipliers from existing I-O data. These multipliers can be used as benchmarks to examine the accuracy of nonsurvey multipliers. It should be noted that the benchmark multiplier is an economic base multiplier. If the benchmark multiplier is closely approximated by a nonsurvey multiplier, it can be argued that the nonsurvey approach approximates the real economic base multiplier. However, given differences in definition, such results do not indicate that the nonsurvey multiplier is a substitute for the I-O model.[18] On the other hand, by proposing an economic base multiplier for evaluating nonsurvey economic base multipliers, the procedure presented here responds to Pfister's[19] related complaint—that I-O multipliers should not be used to measure the accuracy of economic base multipliers.

Table 6 shows both the lower bound multipliers, the survey-based export-base multiplier (benchmark), and the current EIFS multiplier. The bracketing approach was used to calculate multipliers for Kansas and Washington.

The upper bound was calculated using the four-digit SIC code from 1972 employment data from *County Business Patterns*[20] augmented by agricultural and governmental employment data from the BEA. All Federal government employment was treated as exogenous. The lower bound was calculated using division-level BEA data from 1967 through 1973. The benchmarks were calculated

Table 6

The Relation of the EIFS Multiplier to the Lower Bound and the Benchmark

Region	Lower Bound	Benchmark	EIFS
Kansas State	1.80	2.79	3.28
Washington State	1.18	2.02	3.54

using the 1963 Washington I-O transactions table and the 1965 Kansas table.

The upper and lower bounds for the multiplier were 3.28 and 1.80, respectively, for Kansas, and 3.54 and 1.18, respectively, for Washington. The benchmark multipliers were 2.79 and 2.02, supporting the hypothesis that this approach does bracket the survey-based multiplier. Although the bracket is quite large, it can be narrowed by modifications. For instance, incorporation of net national exports and relative income as a proxy for variations in productivity and consumption will reduce the upper bound. Similarly, the lower bound can be increased by assigning state and local government and a portion of services to endogenous employment within a state. (The regression technique commonly assigns such employment to exogenous, since those sectors increased both nationally and regionally.)

Also, it should be noted that the benchmark multipliers are much older than the upper- and lower-bound multipliers. Given the commonly hypothesized increase of multipliers over time, it is quite possible that a benchmark multiplier, calculated with I-O data for the same year used to calculate the upper bound, would be closer to the upper bound than in the previous example.

4 CONCLUSIONS

Documented in this report is the derivation of the EIFS multiplier for the EB/LQ technique for determining economic and related social impacts due to Army military activities. The multiplier described in this report compares favorably with those derived by alternative techniques. The multiplier is better suited to user requirements because of its cost-effectiveness and efficiency in assessing economic impacts.

[18] E. Romanoff, "The Economic Base Model: A Very Special Case of Input-Output Analysis," *Journal of Regional Science* (April 14, 1974).

[19] R. Pfister, "On Improving Export Base Studies," *Regional Science Perspectives* (1976).

[20] *County Business Patterns, 1972,* Tab A-1 Supplement (Department of the Air Force, and U.S. Department of Commerce, October 1976), pp 136-138.

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APPENDIX A:

ECONOMIC TECHNIQUES

EB/LQ

The basic/nonbasic concept must be understood before location quotients are discussed. A basic industry is an industry within a region which produces goods for sale outside of that region (export). An industry which supplies only the needs of the local population and local industry is nonbasic or nonexporting. Basic industries are the basis of a region's economic growth because they bring in money from outside the region. An underlying assumption is that regional economies are open; i.e., a region does not produce everything it consumes, nor does it consume everything it produces.

A region's total employment consists of two components—the basic employment and the nonbasic employment. Nonbasic employment is derived from the basic employment. If the ratio of total employment (TE) to basic employment (BE) is known, one can derive an employment multiplier. For example, if a region has a total employment of three people and one of them is in a basic industry, then the TE/BE ratio is equal to 3/1 and the employment multiplier is 3. This means that for every new basic job created, three total jobs will accrue to the local economy.

The total-to-basic ratio does not remain constant. As regions grow, the ratio typically increases. As a region increases in economic size, it can support more industries in order to supply itself. This means that even a small growth in basic industries will trigger a large total growth in employment. This can be expressed as follows: if the ratio increases, then $\Delta TE/\Delta BE$ is greater than TE/BE (Δ = change). If $\Delta TE/\Delta BE$ is equal to TE/BE, then the ratio is constant. It is obvious that for the ratio to increase, $\Delta TE/\Delta BE$ must be greater than TE/BE.

The basic/nonbasic method has several advantages, one of which is simplicity. It is concerned with changes in the export trades rather than with changes in all industries. In addition, employment data may be used, and these are the most readily available data for an economy. Finally, this technique uses only the volume of local and export activity; flows of imports and incoming capital are not considered.

Employment data can be used to generate the multiplier in export base models. The employment data, in fact, serve as a surrogate for income. As shown in the final part of this section, the Keynes income-based multiplier approximates the EB/LQ multiplier. Using employment as the calculating basis, the multiplier may lead to inaccurate calculation because employment is not as sensitive to productivity and wage as income is. In practice, using employment to estimate the multiplier does not lead to serious differences with income-derived multipliers.

Three assumptions must be made in order to use location quotients as the basis for estimating export activity: (1) patterns of consumption do not vary geographically, (2) labor productivity does not vary geographically, and (3) each industry produces a single, perfectly homogeneous product.

The location quotient is a statistical technique that measures (usually in terms of employment) the degree to which an industry is concentrated in a given region or place. It can be defined as the percentage of local employment accounted for by a given industry divided by the percentage of national employment in that industry.

The location quotient can be expressed as $(e_i/e)/(E_i/E)$, where e_i is the local employment in industry, e is total local employment, E_i is the national employment in industry, and E is the total national employment.

Given the assumption of uniform labor productivity, local demand for a product can be satisfied from local production when e_i/e equals E_i/E and the location quotient is equal to 1. The amount of employment in an industry is basic to that amount which pushes the location quotient above 1. This can be shown as follows:

Let X_i = export employment in the i^{th} industry

$\frac{E_i}{E}$ = the percentage of local employment that would have to be devoted to the production of the i^{th} product to supply local demand

$\frac{e_i}{e}$ = the actual percentage of local employment devoted to such production.

It can then be concluded that $X_i = (e_i/e - E_i/E) \cdot e$.

The total basic regional employment can be estimated by performing this calculation for each industry in the region whose location quotient is greater than 1 and summing the individual results.

The estimate of export employment derived from the preceding example has several assumptions which are not often met. Neither the assumption of uniform consumption nor the assumption of uniform productivity is entirely correct. However, the main problem lies with the third assumption—that each industry produces homogeneous goods. If goods within an industry are not homogeneous, cross- or back-hauling results. The effect of cross- or back-hauling on the multiplier is demonstrated in the following example.

Assume that an automobile plant is located in a region. The percent employment in the area may be less than the national percentage, which means that no export employment is evident in the region. However, to the consumer, automobiles are not an homogeneous product. Automobiles made by the local manufacturer will be exported, while those of another manufacturer will be imported. The export and import of products manufactured by employees in the same employment class are cross- or back-hauling. Failure to account for back-hauling causes understating of the export employment and overstating of the multiplier. This is evident from the multiplier equation, where total employment is divided by export employment.

The location quotient deals implicitly with indirect exports. An indirect export occurs when a local supplier sells a product to a firm which then uses it to make a product that is exported. The location quotient deals with this problem in an imperfect manner, but does treat indirect exports so that the EB/LQ technique is viable.

It can be shown that the basic/nonbasic employment multiplier is related to the foreign trade multiplier of Keynes.[21] The proof is as follows:

Assuming no government sector, it is known that income is equal to output ($Y = \phi$) and that

$$Y = C + I + (X - M)$$

where Y = net national product (personal income)

C = spending on local consumption of goods (including imports)

I = net spending on local investment

M = imports (assumed to be only for consumption)

X = exports.

Therefore, the identity

$$Y = C + I + X - M \qquad \text{[Eq A1]}$$

holds true and

$$C = a + (mpc)Y \qquad \text{[Eq A2]}$$

where a is a constant for autonomous consumption and the following conditions exist:

marginal propensity to consume (mpc) = $\Delta C/\Delta Y$

marginal propensity to import (mpm) = $\Delta M/\Delta Y$

marginal propensity to save (mps) = 1 − mpc

marginal propensity to consume local goods (mpcl) = mpc − mpm.

The foreign trade multiplier (K) can be defined as $K = \Delta Y/\Delta X$. From the income identity, it can be deduced that

$$\Delta Y \equiv \Delta C + \Delta I + \Delta X - \Delta M \qquad \text{[Eq A3]}$$

It is known that $\Delta C = (mpc)\Delta Y$ and $\Delta M = (mpm)\Delta Y$; therefore,

$$\Delta Y = \Delta Y(mpc - mpm) + \Delta I + \Delta X \qquad \text{[Eq A4]}$$

Transposing and factoring this equation yields

$$\Delta Y = \frac{1}{1 - (mpc - mpm)}(\Delta I + \Delta X) \qquad \text{[Eq A5]}$$

If it is assumed that $\Delta I = 0$, and it is known that $K = \Delta Y/\Delta X$, $K = 1/1 - (mpc - mpm)$, which can be restated as

$$K = \frac{1}{1 - mpcl} \qquad \text{[Eq A6]}$$

This means that any change in exports will lead to a change in local income that is K times as great.

The similarity between the Keynesian and basic/nonbasic multipliers is presented below.

[21]James Heilbrun, *Urban Economics and Public Policy* (St. Martin's Press, 1974), pp 144-150.

The basic/nonbasic multiplier is K = Δtotal/Δbasic. Since Δbasic = Δtotal − Δnonbasic, the multiplier can be rewritten as K = Δtotal/(Δtotal − Δnonbasic). This can be transformed to

$$K = \frac{1}{1 - \frac{\Delta \text{nonbasic}}{\Delta \text{total}}} \qquad \text{[Eq A7]}$$

If the basic/nonbasic multiplier were to be stated in terms of income, it would be stated as

$$K = \frac{1}{1 - \frac{\Delta \text{nonbasic income}}{\Delta \text{total income}}} \qquad \text{[Eq A8]}$$

This can now be compared with the Keynesian multiplier where K = 1/1 − mpcl. It should be observed that the term mpcl is the marginal propensity to consume locally and is analogous to Δnonbasic sector income/Δtotal income in the nonbasic multiplier.

I-O Analysis

The basis of I-O analysis is a simple accounting rule: For each economic sector or industry, the sum of all outputs sold must equal the sum of all inputs purchased. Table A1 demonstrates this maxim for a highly simplified economy in which there are only two producing sectors (manufacturing and commercial). Each producing sector produces or "outputs" goods and services and sells them; each sector "inputs" production requirements, which it purchases from itself and other sectors. Thus, reading across the rows, it is observed that manufacturers had a total sales volume of $1200, which was distributed as specified in the table (i.e., $500 to manufacturers, $400 to commercial, etc.). To produce this $1200 worth of goods, manufacturers had to purchase inputs from themselves and other sectors, import items necessary for production from outside the region, and pay for the factors of production (value added). The result is that the sum of all sales equals the sum of all purchases.

Notice that the I-O table has been divided into an "Intermediate Demand Sector" and a "Final Demand Sector." This division is designed to separate those sectors of the economy whose demand for products can be determined by the model and those sectors whose demand is autonomously determined. The former group is also referred to as the processing sector, and the latter group as the final demand sector. When the dollar value of the final demand requirements is specified, the value of all the inputs and outputs necessary to meet the demand is automatically determined.

Predicting Output Levels[22]

The first theory is that for any one sector to produce a unit of output requires inputs from other sectors in fixed proportions. These fixed input proportions are called input coefficients; their values are determined by the existing technological constraints required to produce a unit of output. In effect, the quantity of input purchases (Q) made by sector j from sector i are in the proportion a_{ij} with the level of output of sector i:

$$Q_{ij} = a_{ij} Q_i \qquad \text{[Eq A9]}$$

The input coefficient is

$$a_{ij} = \frac{Q_{ij}}{Q_i} \qquad \text{[Eq A10]}$$

Table A1 shows that the manufacturing sector purchases $300 in inputs from the commercial sector to produce a total output of $1200, or

[22]The following discussion is based on an I-O presentation by Darold A. Krueckeberg and Arthur L. Silvers in *Urban Planning Analysis* (John Wiley and Sons, 1974), pp 406-416.

Table A1

Regional Interindustry and Income Accounts ($)

Output \ Inputs	Intermediate Demand Sector		Final Demand Sector		
	Manufacturing	Commercial	Consumption	Export	Total Sales
Manufacturing	500	400	120	180	1200
Commercial	300	30	360	110	800
Imports	150	170	80	—	400
Value Added	250	200	—	—	450
Total Purchases	1200	800	560	290	2850

$$a_{21} = \frac{300}{1200} = .250$$

The manufacturing sector also purchases $500 of inputs from itself so that

$$a_{11} = \frac{500}{1200} = .4167$$

$150 worth of inputs is imported, so that the import coefficient is

$$m_1 = \frac{150}{1200} = .125$$

and $250 is paid to value added where the value added coefficient is

$$v_1 = \frac{250}{1200} = .2083$$

The input coefficients for the commercial sector can be obtained similarly, leading to construction of a second table called an input coefficient matrix (Table A2).

Table A2

Regional Input Coefficient Matrix

Output \ Input		Manufacturing	Commercial
A_{ij}	Manufacturing	.4167	.5000
	Commercial	.2500	.0375
m_j	Imports	.1250	.2125
v_j	Value Added	.2083	.2500
Total		1.000	1.000

It was stated earlier that when the dollar value of the final demand requirements is specified, the value of all the inputs and outputs necessary to meet the demand is determined automatically. If, for example, consumption demand for manufactured products is estimated to be $150 by 1985 (an increase of 25 percent from its present level), then the manufacturing sector will require a certain level of inputs from the other sectors to produce at an output level that will meet this demand. Specifically, it will require $62.51 ($150 × .4167) from itself, $37.50 ($150 × .25) from the commercial sector, $18.75 ($150 × .2083) in value added. The same principle can be applied to determine the inputs required to satisfy the specific consumer demand on the commercial sector. In effect, each sector responds to demands from the outside in a manner dictated by the input coefficients. Therefore, if input coefficients were calculated for the processing sector and the sector given a set of final consumer demands, the output of the entire economic system could be determined for a future time period. This is the essence of I-O analysis.

The Simple Mathematics of I-O Analysis

The relationships in the income accounts table can be stated as follows: the total sales of each sector (Q_i) minus the sales of intermediate goods to the local sector (Q_{ij}) equals the sales of final goods to the consumption (C_i) and export (X_i) sectors. Algebraically, this is

$$\begin{aligned} Q_1 - Q_{11} - Q_{12} &= C_1 + X_1 \\ Q_2 - Q_{12} - Q_{22} &= C_2 + X_2 \end{aligned} \qquad \text{[Eq A11]}$$

(See Table A1 to confirm that the above statements are true.)

Since Eq A9 has already shown that Q_{ij} can be predicted by the Q_i, the system of equations above may be rewritten as

$$\begin{aligned} Q_1 - a_{11}Q_1 - a_{12}Q_2 &= C_1 + X_1 \\ Q_2 - a_{21}Q_1 - a_{22}Q_2 &= C_2 + X_2 \end{aligned} \qquad \text{[Eq A12]}$$

The output of each sector is found by solving for Q_1. Using matrix algebra, the system of equations is rewritten as

$$\begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix} - \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix} = \begin{bmatrix} C_1 + X_1 \\ C_2 + X_2 \end{bmatrix}$$

which can be rewritten as

$$Q - AQ = [C + X]$$

where

$$Q = \begin{bmatrix} Q_1 \\ Q_2 \end{bmatrix}; \; A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}; \; [C + X] = \begin{bmatrix} C_1 + X_1 \\ C_2 + X_2 \end{bmatrix}$$

Factoring out the Q vector yields

$$[I - A]\,Q = [C + X]$$

Multiplying both sides by the inverse of I − A yields

$$[I - A]^{-1} [I - A]Q = [I - A]^{-1} [C + X]$$

or simply,

$$Q = [I - A]^{-1} [C + X] \qquad \text{[Eq A13]}$$

Eq A13 is the I-O model. It states that to solve for the output levels required for the sectors to meet the predicted demand, it is first necessary to solve for $[I - A]^{-1}$ and multiply it by the consumption and export demand estimates ($[C + X]$).

From matrix algebra, it is known that

$$[I - A]^{-1} = 1/\Delta \text{ Adj } [I - A] \qquad \text{[Eq A14]}$$

where Δ is the determinant of $[I - A]$ and Adj $[I - A]$ is the adjoint of $[I - A]$.

Before solving for $[I - A]^{-1}$, the values of $[I - A]$, $1/\Delta$, and Adj $[I - A]$ must be determined.

$$[I - A] = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} - \begin{bmatrix} .4167 & .5000 \\ .2500 & .0375 \end{bmatrix} = \begin{bmatrix} .5833 & -.5000 \\ -.2500 & .9625 \end{bmatrix}.$$

$$\Delta = (.5833)(.9625) - (-.5000)(-.2500) = .43643.$$

Interchanging the elements along the main diagonal and multiplying the other two elements by −1 yields Adj $[I - A]$:

$$\text{Adj } [I - A] = \begin{bmatrix} .9625 & .5000 \\ .2500 & .5833 \end{bmatrix}$$

Substituting into Eq A14 gives

$$[I - A]^{-1} = \frac{1}{.43643} \begin{bmatrix} .9625 & .5000 \\ .2500 & .5833 \end{bmatrix} = \begin{bmatrix} 2.205 & 1.146 \\ .5728 & 1.337 \end{bmatrix}$$

The $[I - A]^{-1}$ matrix is termed the Leontieff inverse and is one of the most useful results of an I-O study; it provides a set of sales multipliers which give the direct and indirect effects of expenditures by one sector on all the other sectors in the economy. The example indicates that in order to produce \$1 of manufactured goods for final demand, \$2.205 of inputs (sales) were required from all manufacturing industries (\$1 in direct sales and \$1.205 in indirect sales) and \$.573 of indirect sales from the commercial sector. Thus, the manufacturing sector has induced all sectors to produce a certain output to meet a given demand.

Next, the Leontieff inverse can be used to calculate the output level that must have been produced by each sector in the region; that is, the vector of sectoral outputs that served the vector of consumption demand and the vector of export demand should be calculated. From Table A1,

$$C = \begin{bmatrix} 120 \\ 360 \end{bmatrix}$$

$$X = \begin{bmatrix} 180 \\ 110 \end{bmatrix}$$

$$Q_c = [I - A]^{-1} C$$

$$= \begin{bmatrix} 2.205 & 1.146 \\ .573 & 1.337 \end{bmatrix} \begin{bmatrix} 120 \\ 360 \end{bmatrix}$$

$$= \begin{bmatrix} 677.16 \\ 550.08 \end{bmatrix}$$

$$Q_x = [I - A]^{-1} X$$

$$= \begin{bmatrix} 2.205 & 1.146 \\ .573 & 1.337 \end{bmatrix} \begin{bmatrix} 180 \\ 110 \end{bmatrix}$$

$$= \begin{bmatrix} 522.96 \\ 250.21 \end{bmatrix}$$

If the output level required to meet final demand in the consumption sector is Q_c, and the output level required to meet final demand in the export sector is Q_x, their sum should equal total output by each of the intermediate demand sectors:

$$Q_c + Q_x = \begin{bmatrix} 667.16 \\ 550.08 \end{bmatrix} + \begin{bmatrix} 522.96 \\ 250.21 \end{bmatrix} = \begin{bmatrix} 1200.12 \\ 800.29 \end{bmatrix}$$

which approximates the total output (sales) results in Table A1. The overestimate is due to rounding errors which can be minimized by increasing the number of decimal places to which the calculations are carried. Thus, the I-O model has shown that sectoral output in the intermediate demand sector is

a function of final demand stipulations and the input coefficients governing production levels.

The Advantages and Disadvantages of I-O

One of the advantages that the I-O model has over the basic/nonbasic approach is that the value of the multiplier varies according to the sector that receives the initial stimulus. Several multipliers can be identified and are discussed in Miernyk's work.[23] The I-O multiplier is a sales multiplier derived via the Leontieff matrix which is derived from the input coefficients. Conceptually, the reason the I-O multipliers vary is because they are based on input coefficients which vary by sector. In basic/nonbasic analysis, a change in export demand results in its being multiplied by a constant multiplier value, regardless of what economic sector induced or experienced the change. This is not the case in I-O analysis. Table A3 shows the results of (1) an increase of $20 in exports arising from the manufacturing sector while the commercial sector remains constant, and (2) an increase of $20 in exports arising from the commercial sector while the manufacturing sector remains constant.

Table A3

Effects of an Expansion in Exports ($)

	Case 1: Rise in Manufacturing Exports, With Commercial Sector Remaining Constant	Case 2: Rise in Commercial Exports With Manufacturing Sector Remaining Constant
Manufacturing	200	180
Commercial	110	130
Regional Income (Value Added)	459.27	456.58

An increase in exports induced by the manufacturing sector produces a greater change in regional income (value added) than an increase in exports induced by the commercial sector (459.27 vs. 456.58). This occurs because the manufacturing sector uses 12.5¢ worth of imports for every $1.00 of production, whereas the commercial sector uses 21¢ of imports per $1.00 of production (see Table A2). Consequently, a $1.00 rise in manufacturing exports results in less leakage of spending outside the economy in the form of increased imports. Less leakage results in a larger increase in the demand for local output and, hence, a greater ultimate expansion in local output and income.

Thus, one of the advantages of a disaggregated model is that it can answer questions in greater detail, and probably with greater accuracy. Specifically, if one could determine the military's final demands for national industries and calculate input coefficients for these industries, one could determine the direct and indirect effects of military cuts or expansions on the output and income of an economic system.[24]

However, I-O analysis is not without its shortcomings. From a theoretical standpoint, most of the problems stem from the long-run instability of the input coefficients. Recall that constant input coefficients were assumed. This assumption is valid in the short run, since the coefficients do not change rapidly, and small changes which may occur over a short period will not lead to serious projection errors. Over a longer period, input coefficients will be affected by four types of changes.

Perhaps the most fundamental of the changes is that technological changes will affect input patterns, thus affecting the input coefficients. Therefore, long-term forecasts cannot be made with a static I-O model. This particular criticism is being challenged by the development of dynamic I-O modeling, which accounts for changes in technical coefficients.

Changes in relative prices will also affect input coefficients to the extent that some industries can substitute less expensive inputs. If labor costs increase significantly during the forecasting period and capital costs remain constant, more machinery will probably be substituted for labor, thus changing the input coefficients of households to other affected industries.

The appearance of new industries can also affect input coefficients. As Miernyk points out, the rapid growth of the missile industry during the 1950s, with a relative decline in some parts of the aircraft industry, may have been hard to project using a 1950 I-O model.[25] This is because the growth in the missile

[23]W. H. Miernyk, *The Elements of Input-Output Analysis* (Random House, 1965), pp 42-55.

[24]W. Leontieff and Marvin Hoffenberg, "The Economic Effect of Disarmament," *Scientific American* (April 1961) and W. Leontieff et al., "The Economic Impact—Industrial and Regional—of an Arms Cut," *Input-Output Analysis* (Oxford University Press, 1966), pp 184-222.

[25]Miernyk, p. 39.

industry would not be considered in the 1950 model, and projections to 1960 would have overestimated aircraft industry expansion and underestimated missile industry growth.

Finally, changes in local population characteristics as a result of migration may affect supply conditions through changes in labor productivity, and demand conditions through changes in consumption patterns.

Another criticism (based on practical considerations since I-O analysis can be costly) is that multipliers can be calculated by alternative, less expensive methods (e.g., basic/nonbasic and share analysis).

Econometric Modeling

Basic/nonbasic and I-O modeling essentially use simple arithmetic and linear algebra approaches to obtain the multipliers needed for projection; econometric methods use regression analysis to obtain estimates of the values which comprise a multiplier. Furthermore, econometric modeling uses a multi-equation approach, a broad range of variables, and more complex and realistic functions. I-O and econometric modeling can be compared by means of the following example.

A production function shows the relationship between the quantities of various inputs used and the maximum total output that can be realized by using each combination of input quantities. The column vectors in the technical coefficient matrix of the I-O model are production functions. In econometric modeling, one of the most popular forms of a production function is the Cobb-Douglas function. It usually requires only two inputs—labor and capital—as opposed to the many interdependent, interindustry inputs in I-O analysis; however, it provides a more realistic and theoretically satisfying approach because the equation is nonlinear and empirically founded. A form of the Cobb-Douglas function is:

$$Q = AL^{\alpha}K^{\beta}M^{\lambda} \qquad \text{[Eq A15]}$$

where Q = output
L = quantity of labor
K = quantity of capital
M = quantity of raw materials
A = technological effects

and the coefficients α, β, λ are parameters that vary from case to case. The coefficients can be estimated by regression analysis by rewriting the equation in logarithmic form:

$$\log Q = a + b_1 \log L + b_2 \log K + b_3 \log M$$

where b_1, b_2, and b_3 are unbiased estimates of α, β, and λ, respectively, and a is a biased estimate of A.

Given data for a sample of industries on the values of Q, L, K, and M, the coefficients can be estimated to derive a production function. Once the production function is estimated, it can be used with other equations derived by econometric methods to obtain regional employment levels.

The main objections to econometric modeling are statistically based, and include problems of autocorrelation (lack of randomness in regression residuals), measurement errors in the time series data, and the long-term instability in the structural coefficients.

APPENDIX B:

A FOUR-DIGIT EMPLOYMENT PRINTOUT FOR THE FORT POLK, LA, AND FORT BENNING, GA, AREAS AND THE RESULTANT EIFS MULTIPLIERS

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FORT BENNING

COUNTY	STATE	POPULATION	AREA (SQ MI)
barbour	al	22,543	891
lee	al	61,268	612
macon	al	24,841	616
russell	al	45,394	627
chattahoochee	ga	25,813	253
harris	ga	11,520	465
marion	ga	5,099	365
muscogee	ga	167,377	220
stewart	ga	6,511	452
talbot	ga	6,625	390
webster	ga	2,321	195
TOTAL		379,312	5,086

Multiplier = 2.0666

Count of employed persons by detailed industry

SIC CODE	workers	Industry
----	118,254	total
07--	269	agric. srvcs forestry fisheries
0700	108	agric. srvcs & hunting
0730	77	horticultural srvcs
10--	311	mining
1000	145	metal mining
1050	145	bauxite & aluminum ores
15--	6,694	contract constr'n
1500	2,804	gen'l building contractors
1600	875	heavy constr'n contractors
1610	488	highway & street constr'n
1620	387	heavy constr'n n.e.c.
1700	2,337	special trade contractors
1710	577	plumbing heating air conditioning
1720	245	painting,paper hanging,decorating
1730	472	elect. work
1740	330	masonry stonework & plastering
1741	163	masonry & other stonework
1750	121	carpentering & flooring
1751	79	carpentering
1752	42	floor laying & floor work n.e.c.
1760	123	roofing & sheet metal work
1790	117	misc. special trade contractors
1799	98	special trade contractors n.e.c.
179a	145	administrative & auxiliary
19--	31,867	manufacturing
2000	4,692	food & kindred prod.
2010	700	meat prod.
2011	175	meat packing plants

2015	525	poultry dressing plants
2020	527	dairy prod.
2026	527	fluid milk
2050	1,382	bakery prod.
2051	591	bread cake & related prod.
2052	791	cookies & crackers
2070	817	confectionery & related prod.
2071	817	confectionery prod.
2080	715	beverages
2086	466	bottled & canned soft drinks
2087	375	flavoring exctracts & sirups
2200	12,771	textile mills prod.
2210	9,567	weaving mills coton
2260	690	textile finishing exc. wool
2261	690	finishing plants, cotton
2270	1,221	floor covering mills
2271	175	woven carpets & rugs
2272	1,046	tufted carpets & rugs
2280	1,671	yarn & thread mills
2281	1,296	yarn mills exc. wool
2283	375	wool yarn mills
2290	375	misc. textile goods
2296	375	tire cord & fabric
2300	2,253	apparel & other textile prod.
2310	375	men's/boys' suits & coats
2320	629	men's/boys' furnishings
2321	254	men's/boys' shirts & nightwear
2328	375	men's/boys' work clothing
2330	360	women's/misses' outerwear
2339	175	women's/misses' outerwear n.e.c.
2340	513	women's/children's undergarments
2342	513	corsets/allied garments
2380	175	misc. apparel & acc.
2385	175	waterproof outergarments
2390	187	misc. fabricated textile prod.
2399	175	fabricated textile prod., n.e.c.
2400	1,919	lumber & wood prod.
2410	341	logging camps & logging contractors
2420	803	sawmills & planing mills
2421	603	sawmills & planing mills, gen'l
2429	175	special product sawmills, n.e.c.
2430	264	millwork, plywood & related prod.
2433	175	prefabricated wood structures
2500	105	furniture & fixtures
2600	611	paper & allied prod.
2630	375	paperboard mills
2700	884	printing & publishing
2710	412	newspapers
2750	399	commercial printing
2751	314	comm. printing exc. lithographic
2752	199	commercial printing lithographic
2800	204	chemicals & allied prod.
3000	1,188	rubber & plastics prod. n.e.c.
3010	838	tires & inner tubes
3060	175	fabricated rubber prod., n.e.c.
3070	175	misc. plastics prod.

3100	175	leather & leather prod.
3140	175	footwear exc. rubber
3141	175	shoes, exc. rubber
3200	862	stone clay & glass prod.
3250	375	structural clay prod.
3251	375	brick & structural clay tile
3270	477	concrete, gypsum & plaster prod.
3272	118	concrete prod., n.e.c.
3273	210	ready-mixed concrete
3300	823	primary metal industries
3320	800	iron & steel foundries
3321	800	gray iron foundries
3400	683	fabricated metal prod.
3440	457	fabricated structural metal prod.
3449	350	misc. metal work
3460	175	metal stampings
3500	932	mach. exc. elect.
3520	175	farm mach.
3550	585	special industry mach.
3559	550	special industry mach. n.e.c.
3590	116	misc. mach. exc. elect.
3600	1,188	elect. equip. & supplies
3630	175	household appliances
3631	175	household cooking equip.
3670	838	electr. compon. & acc.
3679	838	electr. compon., n.e.c.
3690	175	misc. elect. equip. & supplies
3691	175	storage batteries
3700	175	transp. equip.
3790	175	misc. transp. equip.
3791	175	trailer coaches
3900	391	misc. manufacturing industries
3940	389	toys & sporting goods
3949	389	sporting & athletic goods, n.e.c.
399a	149	administrative & auxiliary
40--	4,098	transp. & other public utilities
4100	103	local & interurban passenger transit
4200	1,200	trucking & warehousing
4210	1,384	trucking local & long distance
4211	850	trucking w/o storage
4214	239	local trucking & storage
4800	1,325	communication
4810	888	telephone communication
4830	353	radio & television broadcasting
4900	909	elect.,gas & sanitary service
4910	210	elect. companies & systems
4920	177	gas companies & systems
4930	375	combination companies & systems
4931	375	elect. & other srvcs combined
50--	3,437	wholesale trade
5010	367	motor veh. & automotive equip.
5013	279	automotive equip.
5020	161	drugs, chemicals & allied prod.
5040	352	groceries & related prod.
5049	95	groceries & related prod. n.e.c.
5060	252	elect. goods

5064	203	elect. appliances tv & radios
5080	509	mach. equip. & supplies
5081	318	commercial mach's & equip.
5090	1,142	misc. wholesalers
5092	178	petroleum & petroleum prod.
5095	134	beer wine & distilled beverages
5098	120	lumber & constr'n mat'ls
5099	51	wholesalers n.e.c.
52--	15,777	retail trade
5200	490	building mat'ls & farm equip.
5210	239	lumber & other building mat'ls
5250	110	hardware & farm equip.
5251	32	hardware stores
5300	2,808	gen'l merchandise
5310	1,419	department stores
5330	360	variety stores
5390	442	misc.gen'l merchandise stores
5400	2,295	food stores
5410	2,171	grocery stores
5500	3,024	automotive dealers & service stations
5510	888	new & used car dealers
5520	200	used car dealers
5530	256	tire battery & acc. dealers
5540	1,175	gasoline service stations
5590	177	misc. automotive dealers
5592	122	household trailer dealers
5600	1,431	apparel & acc. stores
5610	227	men's & boys' clothing & furnishings
5620	413	women's ready to wear stores
5660	279	shoe stores
5700	699	furniture & home furnishings stores
5710	466	furniture & home furnishings
5712	381	furniture stores
5720	100	household appliance stores
5730	77	radio television & music stores
5800	2,663	eating & drinking places
5900	1,572	misc. retail stores
5910	557	drug stores & proprietary stores
5920	139	liquor stores
5930	62	antique stores & secondhand stores
5950	44	sporting goods stores, & bicycle shops
5970	109	jewelry stores
5990	309	retail stores n.e.c.
5992	85	florists
5999	162	misc. retail stores n.e.c.
60--	5,644	finance insur. & real estate
6000	1,131	banking
6020	1,102	commercial & stock savings banks
6100	599	credit agencies other than banks
6120	111	savings & loan associations
6140	279	personal credit instit.
6150	141	business credit instit.
6200	245	security, commodity brokers & srvcs
6210	77	security brokers & dealers
6280	175	security & commodity srvcs
6300	1,314	insur. carriers

6310	840	life insur.
6320	456	accident & health insur.
6400	486	insur. agents brokers & service
6500	944	real estate
6510	301	real estate operators & lessors
6530	164	agents brokers & managers
6550	52	subdividers & developers
6560	355	operative builders
70--	11,802	services
7000	996	hotels & other lodging places
7010	822	hotels tourist courts & motels
7030	26	trailer parks & camps
7031	26	trailer parks
7040	51	membership-basis organzn. hotels
7200	1,664	personal srvcs
7210	751	laundries & dry cleaning plants
7215	27	coin-operated laundries & cleaning
7216	410	dry cleaning plants exc. rug
7230	374	beauty shops
7240	98	barber shops
7300	1,300	misc. business srvcs
7320	45	credit reporting & collection
7340	716	srvcs to buildings
7349	588	misc. srvcs to buildings
7390	304	misc. business srvcs
7392	119	business consulting srvcs
7399	72	business srvcs n.e.c.
7500	596	auto repair srvcs & garages
7530	333	automobile repair shops
7531	77	top & body repair shops
7538	85	gen'l automobile repair shops
7539	77	automobile repair shops n.e.c.
7600	148	misc. repair srvcs
7620	74	elect. repair shops
7622	68	radio & television repair
7690	48	misc. repair shops
7800	175	motion pictures
7830	175	motion picture theaters
7832	175	theaters, exc. drive-in
7900	211	amusement & recrtn. srvcs n.e.c.
7930	58	bowling & billiard establishments
7940	142	misc. amusement recrtn. srvcs
8000	2,183	medical & other health srvcs
8010	597	offices & physicians & surgeons
8020	190	offices & dentists' dental surgeons
8060	375	hospitals
8090	660	health & allied srvcs n.e.c.
8092	475	sanatoria convalescent rest homes
8099	141	health & allied srvcs n.e.c.
8100	217	legal srvcs
8200	1,564	educ. srvcs
8210	331	elementary & secondary shools
8220	1,133	colleges & universities
8600	1,428	nonprofit membership org's
8630	51	labor org's
8640	109	civic & social associations

8660	447	religious org's
8690	613	nonprofit member org's n.e.c.
8900	370	misc. srvcs
8910	122	engineering & architectural srvcs
8930	166	acc'ting auditing & bookkeeping
91--	25,796	total federal
9110	7,789	federal civilian
9120	18,007	military
92--	12,113	state & local
99--	482	unclassified establishments

Nov 30 23:11 1977 Fort Polk Page 1

FORT POLK

COUNTY	STATE	POPULATION	AREA (SQ MI)
allen	la	20,794	774
beauregard	la	22,888	1,161
natchitoches	la	35,219	1,292
rapides	la	118,078	1,318
sabine	la	18,638	873
vernon	la	53,794	1,351
newton	tx	11,657	949
sabine	tx	7,187	456
TOTAL		288,255	8,194

Multiplier = 1.9564

Count of employed persons by detailed industry

SIC CODE	workers	Industry
----	85,781	total
07--	287	agric. srvcs forestry fisheries
0700	183	agric. srvcs & hunting
10--	704	mining
1300	103	oil & gas extraction
1400	346	nonmetalic minerals exc. fuels
1440	346	sand & gravel
1442	346	constr'n sand & gravel
15--	3,040	contract constr'n
1500	982	gen'l building contractors
1600	745	heavy constr'n contractors
1610	362	highway & street constr'n
1620	383	heavy constr'n n.e.c.
1700	836	special trade contractors
1710	221	plumbing heating air conditioning
1720	57	painting,paper hanging,decorating
1730	177	elect. work
19--	9,864	manufacturing
2000	1,206	food & kindred prod.
2010	487	meat prod.
2015	375	poultry dressing plants
2050	375	bakery prod.
2051	375	bread cake & related prod.
2080	151	beverages
2086	151	bottled & canned soft drinks
2400	4,781	lumber & wood prod.
2410	1,066	logging camps & logging contractors
2420	1,821	sawmills & planing mills
2421	1,626	sawmills & planing mills, gen'l
2426	175	hardwood dimension & flooring
2430	1,300	millwork, plywood & related prod.
2432	1,300	veneer & plywood

2500	369	furniture & fixtures
2510	369	household furniture
2511	93	wood household furniture
2514	175	metal household furniture
2600	1,195	paper & allied prod.
2620	396	paper mills exc. building paper
2630	375	paperboard mills
2640	375	misc.converted paper prod.
2643	375	bags, exc. textile bags
2700	222	printing & publishing
2710	195	newspapers
2800	410	chemicals & allied prod.
2840	175	soap cleaners & toilet goods
2841	175	soap & other detergents
2860	175	gum & wood chemicals
3200	189	stone clay & glass prod.
3250	175	structural clay prod.
3251	175	brick & structural clay tile
3400	748	fabricated metal prod.
3440	132	fabricated structural metal prod.
3490	614	misc. fabricated metal prod.
3494	614	valves & pipe fittings
3700	371	transp. equip.
3790	402	misc. transp. equip.
3791	402	trailer coaches
40--	3,075	transp. & other public utilities
4100	511	local & interurban passenger transit
4130	377	intercity highway transp.
4131	377	intercity bus lines
4200	817	trucking & warehousing
4210	760	trucking local & long distance
4211	637	trucking w/o storage
4800	759	communication
4810	550	telephone communication
4900	646	elect.,gas & sanitary service
4910	175	elect. companies & systems
4930	175	combination companies & systems
4931	175	elect. & other srvcs combined
50--	2,538	wholesale trade
5010	175	motor veh. & automotive equip.
5013	103	automotive equip.
5020	76	drugs, chemicals & allied prod.
5040	670	groceries & related prod.
5041	175	groceries, gen'l line
5044	175	poultry & poultry prod.
5047	111	meats & meat prod.
5049	132	groceries & related prod. n.e.c.
5070	173	hardware, plumbing & heating equip.
5072	89	hardware
5080	224	mach. equip. & supplies
5090	761	misc. wholesalers
5092	61	petroleum & petroleum prod.
5099	250	wholesalers n.e.c.
52--	10,655	retail trade
5200	593	building mat'ls & farm equip.
5210	220	lumber & other building mat'ls

5250	168	hardware & farm equip.
5252	125	farm equip. dealers
5300	1,584	gen'l merchandise
5310	560	department stores
5330	161	variety stores
5390	393	misc.gen'l merchandise stores
5400	1,457	food stores
5410	1,460	grocery stores
5500	2,117	automotive dealers & service stations
5510	813	new & used car dealers
5530	85	tire battery & acc. dealers
5540	703	gasoline service stations
5590	57	misc. automotive dealers
5600	657	apparel & acc. stores
5620	139	women's ready to wear stores
5650	220	family clothing stores
5660	121	shoe stores
5700	259	furniture & home furnishings stores
5710	146	furniture & home furnishings
5712	129	furniture stores
5800	2,112	eating & drinking places
5900	1,013	misc. retail stores
5910	147	drug stores & proprietary stores
5920	36	liquor stores
5990	123	retail stores n.e.c.
5992	28	florists
5999	66	misc. retail stores n.e.c.
599a	175	administrative & auxiliary
60--	3,407	finance insur. & real estate
6000	564	banking
6020	564	commercial & stock savings banks
6100	343	credit agencies other than banks
6140	207	personal credit instit.
6300	1,204	insur. carriers
6310	713	life insur.
6320	375	accident & health insur.
6390	177	insur. carriers n.e.c.
6400	238	insur. agents brokers & service
6500	258	real estate
6510	95	real estate operators & lessors
6530	42	agents brokers & managers
70--	8,968	services
7000	149	hotels & other lodging places
7010	146	hotels tourist courts & motels
7200	883	personal srvcs
7210	349	laundries & dry cleaning plants
7216	211	dry cleaning plants exc. rug
7230	84	beauty shops
7240	47	barber shops
7300	399	misc. business srvcs
7340	122	srvcs to buildings
7390	225	misc. business srvcs
7500	114	auto repair srvcs & garages
7530	72	automobile repair shops
7538	28	gen'l automobile repair shops
7600	64	misc. repair srvcs

7900	85	amusement & recrtn. srvcs n.e.c.
7940	72	misc. amusement recrtn. srvcs
8000	3,723	medical & other health srvcs
8010	410	offices & physicians & surgeons
8020	67	offices & dentists' dental surgeons
8060	1,506	hospitals
8090	1,367	health & allied srvcs n.e.c.
8092	1,353	sanatoria convalescent rest homes
8100	166	legal srvcs
8200	423	educ. srvcs
8210	227	elementary & secondary shools
8220	175	colleges & universities
8600	1,700	nonprofit membership org's
8630	37	labor org's
8640	52	civic & social associations
8660	262	religious org's
8690	1,377	nonprofit member org's n.e.c.
8900	177	misc. srvcs
8910	95	engineering & architectural srvcs
8930	80	acc'ting auditing & bookkeeping
91--	26,621	total federal
9110	5,945	federal civilian
9120	20,676	military
92--	16,156	state & local
99--	388	unclassified establishments

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Webster, Ronald D
Development of the Economic Impact Forecast System (EIFS) : the multiplier aspects / by R. D. Webster ... (et al.) -- Champaign, Ill. : Construction Engineering Research Laboratory ; Springfield, Va : available from National Technical Information Service , 1978.
39p. : ill. ; 27 cm. (Technical report - Construction Engineering Research Laboratory ; N-35)

1. Multiplier (economics). I. Ortiz, Luis. II. Mitchell, Ralph. III. Hamilton, W. IV. Title. V. Series: U.S. Construction Engineering Research Laboratory. Technical report ; N-35.